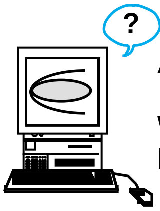

Ask Dr. ALOHA:

When ALOHA Can't Help You

On the morning of July 26, 1993, the community of Richmond, California, just north of San Francisco, had begun to prepare for a fine summer day. The wind was from the southwest at 5 to 7 knots, and the temperature was 70° F under partly cloudy skies. At the General Chemical Corporation facility just outside the city, workers were preparing to offload oleum from a 100-ton tankcar. Oleum is the form in which sulfuric acid is usually transported; it's a mixture of sulfuric acid and sulfur trioxide. At room temperature, oleum is a thick paste that doesn't flow readily, so the workers, following standard procedures, were heating the oleum by running steam through heating coils on the tankcar.

Just after 7:00 a.m., a safety relief valve unexpectedly blew out. No one knows why; the valve was rated to withstand tank pressures up to 100 psi, and the tankcar's pressure gauge read only 55 psi. But a steady stream of vapor began to escape through the 3-inch valve. A thick, white cloud formed around the tankcar and began drifting downwind. The workers on the tankcar were forced to withdraw to a safer location.

As the initial reports of the release came in over the radio, one local emergency response team decided to use the ALOHA air model to predict the downwind dispersion of the escaping pollutant. By this time, the plume of escaping chemical towered high above the General Chemical plant, and the first victims, complaining of stinging eyes and lungs, nausea, and vomiting, had begun to arrive at local hospitals. This accident was clearly an air dispersion problem. But to their surprise, the responders could not find oleum in ALOHA's chemical library. Why wasn't this chemical in ALOHA?

No model can do everything

Models like ALOHA are constantly evolving. Developers are adding new features and refining old ones. But regardless of what anyone tries to tell you, no model, including ALOHA, can accurately model all possible releases. Perhaps the most crucial skill that you need to effectively use ALOHA – or any other air model – is to be able to recognize the times when you won't be able to get good results from the model. This skill can save you valuable minutes during a hazardous materials incident. It can stop you from using inaccurate results from the model as a basis for response decisions. And it can help you to do the best possible job of planning for hazardous chemical emergencies in your community.

Let's look at two important ways in which ALOHA is not designed to model the release at Richmond:

ALOHA isn't designed to model mixtures or solutions

Oleum is a mixture of two chemicals that behave very differently. One of them, sulfuric acid, has an extremely low vapor pressure except at very high temperatures, but the other, sulfur trioxide, is more volatile. When sulfur trioxide is heated, as it was during the Richmond accident, it can escape into the atmosphere readily enough to present a hazard to people.

ALOHA is designed to model release and dispersion of pure chemicals only. No mixtures or solutions are included in the model's chemical library. Why is this so, when many hazardous substances are mixtures or solutions? In fact, ALOHA's developers hope eventually to include the ability to model at least some mixtures and solutions in the model. But they also are committed to ensuring that the model produces accurate and reliable information, remains easy to use, and makes its calculations fast enough to be useful during an emergency response. Modeling mixtures and solutions poses more difficult problems than modeling pure chemicals. The necessary calculations are more complex and time-consuming, and more information would be required from the user. The model would need to account for at least two different sets of physical properties exhibited by two or more different chemicals, instead of just one set of properties for a single chemical. It would need to adjust for changes over time in the proportion of each chemical in the mixture whenever mixture components differing in volatility escape at different rates during a release. ALOHA's development team has not yet found a way to add all these features without losing ALOHA's ease of use, speed, and reliability.

ALOHA doesn't account for chemical reactions

When some chemicals are accidentally released, either as mixtures or alone, they can react together or with other chemicals in the environment. Reactions can result in the formation of completely new chemicals. In such cases, the chemicals dispersing downwind may be completely different from the chemicals that originally escaped from a container. Reactions can also change the temperature of the escaping pollutant. Chemical reactions are either "endothermic," requiring heat from the environment, or "exothermic," releasing heat to the environment.

At Richmond, a variety of chemical reactions may have occurred. An especially important one would have been the reaction of sulfur trioxide with water to form sulfuric acid. This reaction is highly exothermic; it releases a lot of heat. When sulfur trioxide within a vapor cloud reacts with water in the atmosphere, the reactions can heat up the cloud and cause it to be more buoyant than we would otherwise expect. That's what may have happened during the Richmond release. People who saw the cloud as it first formed reported that it began to roll along the ground like a heavy gas. That's what we would expect if no reactions were taking place, because both sulfur trioxide and sulfuric acid have molecular weights much heavier than air. But the plume rising from the tankcar eventually attained a height of about 1000 feet. This degree of plume rise suggests that over time, the vapor cloud may have been heated considerably from within.

ALOHA does not account for the effects of the chemical reactions that may have occurred within the Richmond vapor cloud, or the plume rise that may have been caused by these reactions. Even if it were able to do so, it's unlikely that during the confusion of a response, the model's users would have been able to quickly track down accurate values for the inputs that the model would have required. Just for starters, the model would have needed to know the percentage of sulfur trioxide within the oleum in the tankcar in order to estimate the amount of sulfur trioxide that might escape into the air and the possible degree of heating from sulfur trioxide's reactions with water. This percentage commonly ranges between 10 and 65%.

Check ALOHA's list of limitations

If your model isn't designed to handle a particular accident scenario, or if you can't quickly obtain good values for the inputs that your model needs, you'll be able to respond better to a hazardous chemical accident by not using the model at all. At Richmond, the plume from the oleum tankcar was clearly visible. Observations of its movement allowed responders to track its movements much more accurately than any predictive model could.

Whenever you need to decide whether ALOHA can help you respond to a chemical accident, quickly review the list of limitations that ALOHA presents to you when it starts up.

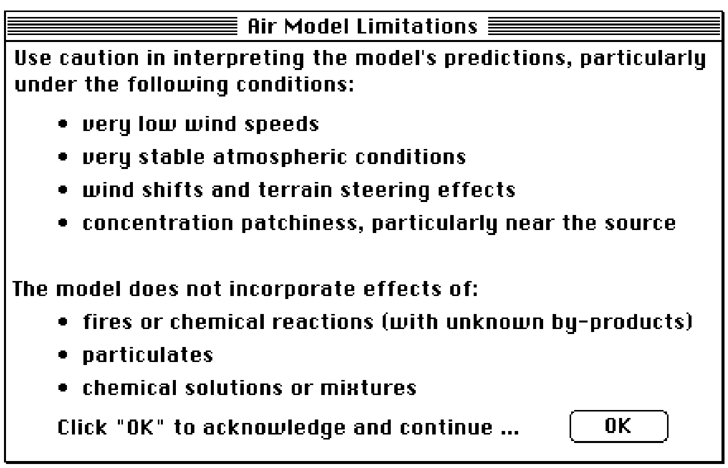

Figure 1. ALOHA's list of limitations.

It will warn you that it cannot account for chemical reactions and cannot model chemical mixtures and solutions. Don't use ALOHA when these effects are present; it won't be able to help you. Rely instead on your own observations, your own experience and judgment, and information about the escaping pollutant that you can quickly obtain from CAMEO or from other sources.

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